

Contract Number: W9132T-04-C-0018

Offeror: IdaTech, LLC

IdaTech 2003 PEM Demonstration Program  
in Rappahannock, VA with Fort AP Hill/Rappahannock Electric Cooperative

US Army Corps of Engineers  
Engineer Research and Development Center  
Construction Engineering Research Laboratory  
Broad Agency Announcement CERL-BAA-FY03

**Locations**

Fort AP Hill, Administration Building, Rappahannock, Virginia

**July 5, 2005**



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## Executive Summary

The offeror and manufacturer, IdaTech, will conduct a demonstration of one PEM fuel cell system at Fort AP Hill in Rappahannock, VA with subcontractor Rappahannock Electric Cooperative (REC). The Fort AP Hill system will use propane fuel, operate off-grid, and be located outdoors. The system will not operate in CHP mode.

The energy generated from the demonstration is estimated to be approximately 15,768 kWh of electricity assuming that the fuel cell system operates at an average output of 2.0 kW for 90% of a full year.

The point of contact at Fort AP Hill is Brian Robinson, 804-633-8262, 18436 4<sup>th</sup> St., Fort AP Hill, VA 22427, [brian\\_1\\_robinson@belvoir.army.mil](mailto:brian_1_robinson@belvoir.army.mil).

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**Proposal – Proton Exchange Membrane (PEM) Fuel Cell Demonstration of Domestically Produced Residential PEM Fuel Cells in Military Facilities**

1.0 Descriptive Title

IdaTech 2003 PEM Demonstration Program in Rappahannock, Virginia with Fort AP Hill/Rappahannock Electric Cooperative.

2.0 Name, Address and Related Company Information

Name: IdaTech, LLC (IdaTech)  
Address: 63065 N.E. 18<sup>th</sup> St., Bend, OR 97701  
Phone: 541-383-3390  
Fax: 541-383-3439  
DUNS Number: 95-789-2193 CAGE Code: 1M0T9  
TIN: 93-1202376

Located in Bend, Oregon, IdaTech is a world-class energy technology company focused on the development and commercialization of fuel processor technology and integrated Proton Exchange Membrane (PEM) fuel cell solutions. Founded in 1996, IdaTech has developed some of the most compact and efficient fuel processors and fuel cell systems operating on a variety of common fuels, including natural gas, propane, methanol, and low-sulfur liquid hydrocarbons. Additionally, IdaTech continues integrating its fuel processor technology with the best available fuel cell power modules to develop power systems from 250 watts to 50 kilowatts for a wide range of portable and stationary applications. These systems are being demonstrated, evaluated, and field-tested in various applications with business partners in North America, Europe, and Japan. IdaTech currently employs approximately 90 people.

3.0 Production Capability of the Manufacturer

As described in Section 2.0 above, IdaTech is a world-class developer and manufacturer of fuel cell systems and fuel cell components including fuel processors and fuel cell stacks and is fully capable of supplying the required components for the proposed systems. IdaTech manufactured approximately 25 fully integrated fuel cell systems in 2003 and 30 systems in 2004. IdaTech's philosophy towards manufacturing volume and demonstrations is orderly development. In practice, this means IdaTech manufactures enough systems to statistically validate technology advances and then places a limited number of those systems in the field to further validate the technology. This discipline ensures that IdaTech engineers are able to advance development goals rather than continuously support prototype demonstrations. IdaTech has selected this CERL opportunity due to its outstanding opportunity to display high performance in a well-publicized forum to a key target market.

In support of the field demonstration IdaTech provided support through 80 hours of on-site field installation services and 30 hours of training service with the delivery of the fuel cell system. Site preparation including an appropriate pad, plumbing potable water,

electrical interconnection with load including transfer switch if needed and any required security and landscaping are the responsibility of the host site and partner utility. Site remediation is also outside the scope of the fuel cell manufacture and will be provided by the host site and utility partner.

IdaTech contact information is detailed in Section 2.0 above.

4.0 Principal Investigator(s)

William A. Pledger  
Senior Vice President & Chief Engineer  
IdaTech, LLC  
Phone: 541-322-1025  
Fax: 541-383-3439  
E-Mail: [bpledger@idatech.com](mailto:bpledger@idatech.com)

Education

1982: B.S. in Chemical Engineering, Oregon State University, Corvallis, Oregon

Professional Accreditation

1997: Professional Engineer in State of Oregon

Professional Highlights

1996-Present: Senior Vice President, Chief Engineer, IdaTech, LLC. Directs design, development and testing of fuel cell systems and major subsystems. Areas of expertise include metallic membranes, membrane reactors, membrane module design and construction, chemical process equipment and process modeling.

1994-1996: Chief Engineer, Micromonitors, Inc., Bend, Oregon. Responsible for field-testing and evaluation of microelectronic, electrical transformer fault gas analyzers.

1992-1994: Senior Engineer, Bend Research, Inc., Bend, Oregon. Responsible for design and construction of membrane-based systems and pilot plants. Areas of expertise include process modeling and electronic system design and construction.

1985-1992: Research Engineer, Bend Research.

Bill Pledger can be reached through the contact information listed in section 2.0 above.

5.0 Authorized Negotiator(s)

Name: Hal Koyama  
Title: Vice President of sales and Marketing  
Company: IdaTech, LLC  
Phone: 541-322-1000  
Fax: 541-383-3439  
Email: [hkoyama@idatech.com](mailto:hkoyama@idatech.com)

## 6.0 Past Relevant Performance Information

IdaTech has been successful developing systems and solutions that specifically address a customer's or development partner's business problem. The following is a list of recent examples:

1. Scaleable power solution for The U.S. Army Communications – Electronics Command (CECOM). CECOM contracted with IdaTech to develop a 2 kW fuel cell system to power an array of communications and other electronic equipment on a High Mobility Multipurpose Wheeled Vehicle (HMMWV - pronounced Hum-Vee).  
Customer: US Army – CECOM  
Contact: Nicholas Sifer – FC Program Manager  
Phone and/or e-mail: 703-704-0272 / Nicholas\_Sifer@bemi01.belvoir.army.mil  
Contract #: DAAB0798DH502/0039  
Dollar Value: ~US\$ 226,000
2. Hybrid power solution combining fuel cells with photovoltaics – IdaTech and Electricite de France (EDF) jointly integrated a fuel cell system with photovoltaic (PV) technology in a hybrid power system for remote locations.  
Customer: Electricite de France  
Contact: Thierry Brincourt  
Phone and/or e-mail: 33 1 60 73 71 01 / thierry.brincourt@edf.fr  
Contract #: F 57992/0  
Dollar Value: ~US\$ 455,000
3. Propane fueled fuel cell system for telecommunication applications – Working under two funding grants from the Propane Education and Research Council (PERC), IdaTech proved its' capabilities related to fuel processing and system integration for propane fueled fuel cell systems.  
Customer: Propane Education and Research Council (PERC)  
Contact: Larry Osgood  
Phone and/or e-mail: 719-487-0080 / LDOgood1@aol.com  
Contract #: Docket No's 10229 & 10857  
Dollar Value: ~US\$ 742,000
4. Natural gas fuel cell system for German Utility – Over a three month period, IdaTech worked closely with a German Utility for the design and development of a fully integrated natural gas fuel cell system for a multi-family building. IdaTech leveraged its modular design philosophy and took existing building blocks (fuel cell module, fuel processor module, power electronics, etc.) to have a system ready for factory acceptance testing within 60 days from time of contract.  
Customer: German Utility  
Contact: N/A (due to NDA)  
Phone and/or e-mail: N/A (Due to NDA)  
Contract #: 6560  
Dollar Value: ~US\$ 203,000

## 7.0 Host Facility Information

Fort AP Hill is a U.S. Army installation near Bowling Green, VA, located 20 miles southeast of Fredericksburg, VA. The installation is named in honor of Lieutenant General Ambrose Powell Hill, a Virginia native who distinguished himself as a Confederate commander during the Civil War. The fort was first established as an Army training and mobilization area in 1941. It was an important staging area during World War II, where more than 75 percent of the North African invasion force was trained and equipped. Today, the post's 75,944 acres make it the sixth largest military installation on the East Coast. Fort AP Hill is used for training by more than 150,000 Active military, National Guard, and U.S. Army Reserve soldiers annually. It truly is one of the nation's premier all-purpose, year-round, field training destinations with nearly 76,000 acres, including a 27,000-acre live fire complex. The National Scout Jamboree location is staged near the center of Fort A.P. Hill.

Fort AP Hill will be acting as a Project Partner and Site Owner to IdaTech. As the Site Owner, Fort AP Hill will be responsible for identifying the site and gaining necessary approvals to site the fuel cell systems with the command of the base. Additionally, Fort AP Hill personnel will be involved in operational training and participate in the installation and maintenance activities as required. Brian Robinson is authorized to act on behalf of A.P. Hill during the proposal development, site selection process, contract negotiations, and installation/operation of the fuel cell system. Brian is the acting Director of Public Works. Contact Information: 804-633-8262 or via e-mail at [brian\\_l\\_robinson@belvoir.army.mil](mailto:brian_l_robinson@belvoir.army.mil).

Rappahannock Electric Cooperative (REC) is the electricity provider to FT AP Hill, a consumer owned utility which provides electric service to more than 80,000 connections in parts of 16 Virginia counties. It was formed in 1980 with the merger of two cooperatives, Virginia Electric Cooperative in Bowling Green and Northern Piedmont Electric Cooperative in Culpepper. The cooperative's General Offices are in Spotsylvania County. REC maintains over 10,000 miles of power lines through its service area, which ranges from the Blue Ridge Mountains to the mouth of the Rappahannock River. REC serves a variety of residential, commercial, and industrial accounts. On August 1, 2002, REC officially became responsible for approximately 200 miles of electric distribution lines at Fort AP Hill. This transfer was the result of more than four years of work between REC, AP Hill, the U.S. Army Corps of Engineers, Baltimore District, and the Military District of Washington Acquisition Center at Fort Belvoir.



**Figure 2.** Front Gate at Fort AP Hill

#### 8.0 Fuel Cell Installation

Site 2: Fort AP Hill with Rappahannock Electric Cooperative in Caroline County, VA operates outdoors, off grid and continuously powers 2 kW AC of security lighting. The system is located at the Administrative Support Building.

The fuel cell system contains five process flow connections. They are: a 6" galvanized duct for the system exhaust, a 1/2" NPTM fuel inlet, and a 3/8" tube "push-connect" for the de-ionized water inlet. An external multi-stage water treatment system is supplied with this system. There are also some electrical connections for power and remote monitoring.

The ancillary equipment included in this system are: a DC/AC inverter designed to take the DC voltage from the fuel cell and change it to 120/240 VAC output, absorbed glass mat lead acid batteries in a 120 V/26 amp hour bank, fuel clean up module for sulfur removal, a water purification system that has been designed with knowledge of local water quality, a rugged outdoor enclosure to withstand the elements, a heater designed to keep the system from freezing, and a radiator system for heat dissipation.



**Figure 3.** The IdaTech fuel cell system is located on the north side of the Administration Building at Fort AP Hill.

The operating procedure for the system is to provide power for security lighting of approximately 2 kW<sub>e</sub>. This serves as the systems base load. The fuel consumption at base load conditions should be approximately 6 slm of propane (@25°C) and 40 ml/min of water. The system ramps up as necessary to match an increase in the load. The fuel consumption at maximum output is approximately 12 slm of propane (@25°C) and 80 ml/min of water. The system is designed for unmanned operation unless the system calls for outside intervention. The run data from the system is retrieved by IdaTech.

Combustion exhaust and other gases are exhausted from the fuel cell system through an exhaust duct located at the back of the system enclosure. These gases must be vented through the roof of the outdoor shade structure. The exhaust ducting system includes a fan that must be installed in the exhaust duct.

The fuel cell system installation was performed from November 29, 2004 to December 3, 2004. All the site work was completed in advance of the installation. For preliminary site work as well as onsite system support, the services of Rappahannock Electric Cooperative were retained. With regard to preliminary site work, Rappahannock Electrical Cooperative was responsible for obtaining site permits, authorizations, preparing the site for installation, procuring and installing the LPG tank and lines, and assisting with the installation including hook-ups for LPG, water, electrical connections to power/utility panels, etc. Two IdaTech field service engineers were onsite performing the actual installation. During the installation period Rappahannock employees received onsite training so that they could perform routine maintenance on the fuel cell system. A picture of the installed system is shown in Figure 4.



**Figure 4.** Completed site picture of the IdaTech fuel cell system located at the Administration Building at Fort AH Hill.

One major challenge encountered shortly after installation was freezing of the system due to cold weather. This possibility was anticipated by IdaTech and as a result, propane space heaters were installed in the system. Unfortunately, the manufacturer of the space heaters issued a safety recall and the heaters had to be turned off. The fuel cell system shut down during this period and as a result, subsystems that contained water froze and were damaged. The components that were obviously damaged were replaced, but identifying all the damaged components required weeks of trouble shooting.

#### 9.0 Electrical System

The fuel cell system is operated at 2.0 kW AC electrical output and is used to power security lighting. The system is operated exclusively in grid-independent mode and provides only AC output.

The system is interconnected to the host site using a sub-panel and automatic transfer switch (ATS). The sub panel is used to break out the circuit from the grid connected source, and power those circuits using the fuel cell system. An ATS is installed that will be capable of transferring the sub-panel circuits back to grid power if the fuel cell system goes off-line for any reason.

One challenge that was encountered with the electrical system was with the Grid-Independent inverter. The manufacturer (Magnatek) was behind schedule in completing the development of the inverter, and when it was initially installed there were a number of issues with the controls and hardware of the inverter. While the controls optimization still needs to be completed, hardware solutions were implemented to prevent overcharging of the batteries.

10.0 Thermal Recovery System

Not applicable.

11.0 Data Acquisition System

The data acquisition system is a National Instruments Field Point measurement and control system. The data is recorded as a text file and is downloaded by IdaTech on a daily basis and put into a database for data mining purposes. The major parameters being monitored by the system are various reactor and fuel cell temperatures and pressures that are pertinent to control and safety. The fuel and water flow rates are monitored as well as the power output of the system. If any one of these parameters, or others that are monitored by the system, displays an out of range value it will cause a system fault.

All faults cause the fuel cell system to shut down. Upon sensing a fault condition, the fault indicator will illuminate, and the fuel cell system will automatically transition to the shutdown state and then to standby after the shutdown process has completed. The shutdown process requires approximately 5 minutes. During the shutdown process, the fault indicator will remain illuminated.

After reaching the standby state, the fault indicator will remain illuminated. All faults must be acknowledged and cleared by the user before the fuel cell system can be restarted. From the standby state, the fuel cell system may be restarted, or disconnected from the electric power source by opening the all-pole switch or disconnecting the plug and socket.

Due to security issues, IdaTech was not able to connect to a high speed data line at the site. Typically, IdaTech has required a high speed data connection in order to monitor and remotely control the system. For this installation, IdaTech elected to use satellite communications in order to access system data. Reliable communication with the system was the number one problem encountered during the initial months of operation. There were weather-related issues as well as hardware issues. Frequently, IdaTech was unable to remotely connect to the system to perform trouble-shooting or monitor system operation. Snow buildup on the satellite dish prevented communication and required site visits to remove the snow. In some cases the snow prevented the subcontractor from making a site visit. Hardware issues centered around keeping the satellite modem in an awake mode. After several months of working with the satellite provider, IdaTech believes that the hardware issues have been addressed.

## 12.0 Fuel Supply System

A 500 gallon propane tank supplies fuel to the fuel cell system. The propane specifications are:

- Contains less than 20% butane and heavier components in the gas phase (at 32°F).
- Sulfur content averages  $\leq 25$  ppm on a yearly basis.
- Supply pressure is 7" to 15" water column.
- Nominal flow rate is 12 slm at full output.

## 13.0 Installation Costs

The table below compares the estimated installation cost with the actual costs incurred.

**Fort AP Hill Installation Cost**

	Budgeted Cost	Contractor Cost (as Billed)
REC Mechanical	\$500	\$0
REC Electrical	\$1,200	\$800
REC General	\$500	\$1,500
Crane/Forklift	\$250	\$250
Communications	\$200	\$1,109
Propane Installation	\$300	\$903
Other Electrical	\$1,800	\$750
Other Mechanical	\$2,000	\$100
Sun/Snow Shelter	\$0	\$2,440
IdaTech Technician	\$2,560	\$5,120
IdaTech Travel	\$2,690	\$2,119
<b>TOTAL</b>	<b>\$12,000</b>	<b>\$15,091</b>

## 14.0 Acceptance Test

Prior to shipping the system, a factory acceptance test was performed. The data can be seen in Appendix B. The procedure followed during the factory acceptance test is shown in the table below. The only site acceptance test performed was to demonstrate to the customer that the fuel cell system could meet the required electrical load.

## CERL Factory Acceptance Test Procedure

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#	Action	Description
1	Start system	System will execute standard start-up sequence beginning at standard room temperature (20-25°C). Record time to "Online" on the report sheet (# 1).
2	No Load	System will respond by charging batteries.
3	Apply medium load	System will respond by matching load and charging batteries.
4	Measure electrical output and efficiency	Record measurements.
5	Apply high load	System will respond by matching load and charging batteries.
6	Measure electrical output and efficiency	Record measurements.
7	Test Complete	System pass / fail.

**Appendix A**  
**Monthly Data Reports**

Contract Number W9132T-04-C-0018

Monthly Data Report

June 2005

Proton Exchange Membrane (PEM) Fuel Cell Demonstration  
Of Domestically Produced PEM Fuel Cells in Military Facilities

US Army Corps of Engineers  
Engineer Research and Development Center  
Construction Engineering Research Laboratory  
Broad Agency Announcement CERL-BAA-FY03

Prepared By  
William A. Pledger  
IdaTech, LLC

Fort AP Hill, Virginia

### **1.0 Fuel Cell Site**

Fort AP Hill, Administration Building, Rappahannock, Virginia. One propane fuel cell system, serial number 0083D is located at this site.

### **2.0 Summary/Milestones**

Although this system was installed in November 2004, numerous weather-related and remote communication issues delayed the official start date for this system. The official start date for this system is June 1, 2005. Availability for the month of June 2005 for this system is 98.7%.

### **3.0 Scheduled Outages**

System Number: 0083D  
Outage Date(s): None  
Duration:

Description:

### **4.0 Unscheduled Outages**

System Number: 0083D  
Outage Date(s): June 27, 2005  
Duration: 9.5 hours

Description: Burner control fault. System was restarted with a couple of subsequent pressurization timeouts, then came online with no other issues.

### **5.0 Component Replacement**

System Number: 0083D  
Replaced Component: None  
Date Replaced:  
Total Component Run Hours:  
Description:

### **6.0 Other Comments**

None

## Appendix B

### Acceptance Test Data

#### CERL FAT Test Summary

(AP Hill Propane system)

System Serial Number: 083D

		Measured						Calculated				
Time	FAT Test Step	Net AC	AC BoP	Battery (viewer)	Gross Stack (viewer)	DC BoP	Fuel-Flow (Viewer)	Thermal (viewer)	Thermal corrected	Est Net AC	Elec Eff.	CHP Eff.
		Watts	Watts	Watts	Watts	Watts	L/min	Watts	Watts	Watts		
3:10 PM		1764	376	-550	3630	478	7.4	5000	3947.368	2314	22.4%	
4:03 PM		3461	426	-526	5520	560	12.2	7300	5763.158	3987	23.4%	

\* Positive discharging

CH2

AC BoP

CH3

Gross Stack Power

CH4

DC BoP

CH5

Gross AC

Propane LHV

1397

Watts per liter per minute

Cp Cool (actual)

3.3

kJ / kg

Water /glycol mix

Cp Cool (viewer)

4.18

kJ / kg

Water

## Availability, Energy Consumption and Production Summary

[illegible]